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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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INVENTOR(S)

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☐ *Additional inventors are being named on the _______ separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

Mapping the Coronary Arteries on a Sphere in CT Angiography

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ENCLOSED APPLICATION PARTS *(check all that apply)*

- ☑ Specification *Number of Pages* 4
- ☐ Drawing(s) *Number of Sheets*
- ☐ Application Data Sheet. See 37 CFR 1.76
- ☐ CD(s), Number
- ☐ Other (specify)

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

- ☐ Applicant claims small entity status. See 37 CFR 1.27.
- ☐ A check or money order is enclosed to cover the filing fees
- ☑ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 14-1270
- ☐ Payment by credit card. Form PTO-2038 is attached.

FILING FEE AMOUNT ($): $160.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

- ☑ No.
- ☐ Yes, the name of the U.S. Government agency and the Government contract number are: ______________________

Respectfully submitted,

SIGNATURE [signature]

Date 08/04/2003

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USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

Mapping the Coronary Arteries on a Sphere in CT Angiography

By: Guy Lavi

The following relates to computed tomography imaging and the visualization of the coronary arteries tree from CT-acquired data. It particularly relates to revealing the entire coronary tree and its topology, in its context (i.e. the surrounding chambers) in the familiar environment of slabbed maximum-intensity projection (MIP), with high linkage to traditional angiography look. Current methods for coronary arteries inspection, such as the curved MPR (multi-planar reformation) of a single vessel, the planar slab MIP or the volume-rendered isolated tree, either lack the completeness or the context of the coronary tree.

Based on the assumption that the coronary arteries lie on a rather smooth closed surface that can be approximated by a sphere or an ellipsoid, such a body is best fitted to the arteries centerlines as seen in figure 1. Then, the centerlines coordinates are converted to spherical (or ellipsoidal) coordinates. That is, longitude and latitude (λ, φ) and height above the sphere (h) according to equation 1, where X,Y,Z are the cartesian coordinates of a centerline point, and R is the radius of the sphere.

$$\varphi = a\tan\left(\frac{Z}{\sqrt{X^2+Y^2}}\right)$$

$$\lambda = a\tan\left(\frac{Y}{X}\right)$$

$$h = \frac{\sqrt{X^2+Y^2}}{\cos\varphi} - R$$

Equation 1

Serving as a base surface, the sphere is locally stretched along the sphere normals to fit the form of the arteries where a centerline is placed. Slicing the volume data with the resulting surface, adding some thickness to it for slabbed MIP, will produce the "True Form" mode of visualization in which the coronary arteries tree in its context is revealed over a real surface running through the vessels. This mode is with substantially reduced distortion, if any at all. Draping the sliced data of the "True Form" on the sphere/ellipsoid that served as a base surface, by projecting the voxels along the normals to the sphere/ellipsoid at each point, will end up in the "Globe" mode of visualization in which the coronary tree is shown on a sphere best fitted to the real surface mentioned above. If, alternatively, the sliced data is stretched over a plane defined by λ and φ (the spherical latitudinal and longitudinal coordinates), w could get the third mode of visualization which is a 2D map of the entire tree and its surrounding parts of the heart.

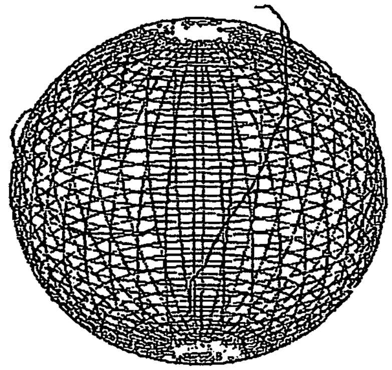

Figure 1 A sphere is best fitted to the arteries centerlines

The visualization concept developed proposes three modes as described. Each of the modes is depicted in figures 2-4. In all three modes of visualization mentioned above, the user may explore the entire structure of the cardiovascular system at once. In all modes the user is able to adjust the thickness of the slab MIP to include more or less data in the image presented. Both the "Globe" and the "True Form" are texture-mapped surfaces around which the user can swivel using standard real-time maneuvering tools. As can be seen in figures 3 and 4, geometric distortion was minimized and can hardly be noticed (Distortion in the "True Form" mode is substantially reduced). Local distortions that might obscure stenosis hardly exist, if at all.

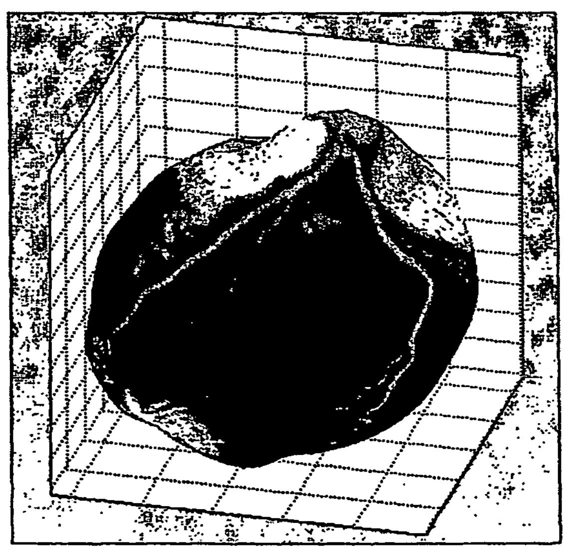

Figure 2 The "True Form" mode of visualization

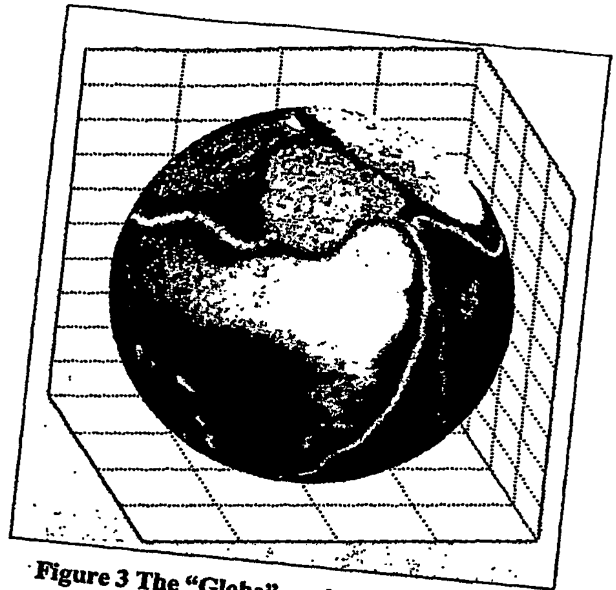

Figure 3 The "Globe" mode of visualization

Figure 4 The "Map" mode of visualization

The visualization concept described simultaneously shows the structure of the cardiovascular system in a slab-MIP-type technique while preserving the context of the vessels (like the aortic origin or the vicinity of the arteries all along their paths) and thus preserving user's orientation in addition to the completeness of the information he gets. A closed non-planar surface is used as a base for projection of the data of interest. Reduction of distortions in the "Globe" and "Map" modes of visualization is also provided.

An advantage of an embodiment of the inventions is that it provides a fast and yet profound examination, with reduced concern of losing information since substantially no data is removed, if at all. This provides more complete and detailed picture at one shot. The visualization concept shown for revealing the cardiovascular system may also be applied to angiographic studies of any other organ that form a closed shape resembling an ellipsoid and that is fed by vessels on its envelope that may be partially occluded (e.g. the brain).

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